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L. O. HOWARD, Chief

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THE SUGAR-BEET THRIPS.[1]

By WM. H. WHITE, *Scientific Assistant, Truck Crop and Stored Product Insect Investigations.*

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INTRODUCTION.

During the winter of 1916 the sugar-beet thrips (*Heliothrips femoralis* Reuter) was found in large numbers in a greenhouse at Washington, D. C. While attacking a variety of plants, the insect confined itself principally to sugar-beet seedlings. Although long recognized as a greenhouse pest, the sugar-beet thrips occurs out of doors in some localities and is recorded as having a large number of food plants. Short notes on its injurious habits have been recorded and published from time to time, but as far as known the life history and habits of the immature stages hitherto have not been fully determined.

GENERAL DESCRIPTION.

In color this species is dark brown or black, the head, prothorax, and the end of the abdomen being reddish yellow. The eyes are dark brown. The forelegs are yellow, the middle and posterior pair yellow with brown femora or thighs. The wings are dusky, the posterior pair lighter, crossed by a white band at the base and a white band about two-thirds the distance from the base; the tips are white. The antennæ are three times as long as the head. The total length is about 1.3 millimeters.

[1] The writer wishes to express his appreciation to Dr. F. H. Chittenden, under whose direction this work was conducted, for many helpful suggestions, and to Mr. J. D. Hood, for furnishing many references to literature pertaining to this subject.

HISTORY.

The sugar-beet thrips was first described by Prof. O. M Reuter (1),[1] from specimens taken in the greenhouse in 1891, at Helsingfors, Finland. The first record we have of its occurrence in the United States was made by Mr. Theo. Pergande (2), who described it in 1895 as *Heliothrips cestri* n. sp., and wrote that it had been known to him since 1884, at which time specimens were presented by Mr. P. B. Mann, who discovered them infesting a plant of *Cestrum nocturnum* from Massachusetts. He also stated that about the same time it was sent to him from Helsingfors, Finland; and that in 1883 he discovered the same species, extremely abundant on leaves of an amaryllis, in a conservatory of the Department of Agriculture at Washington, D. C. It was redescribed by Uzel in 1895 (3), and again by Hinds in 1902 (6). Since that time we have brief records of its occurrence in many localities in the United States and elsewhere.

DISTRIBUTION.

The sugar-beet thrips is widely distributed and is found principally in greenhouses. It is recorded as occurring in greenhouses in the British Isles, Italy, Belgium, Austria, Finland, German East Africa, Sweden, and Spain.

It is also well distributed over the United States, and is reported from the District of Columbia; Lacrosse, Wis.; Ithaca, N. Y.; Vienna, Va.; Urbana, Ill.; Champaign, Ill.; Lincoln, Nebr.; and Amherst, Mass.

The first observation which we have of its occurrence on sugar beets and out of doors was made by Dr. F. H. Chittenden (7), who collected specimens at Washington, D. C., on August 15, 1904. He also observed it on greenhouse sugar beets. In 1907 it was collected on sugar beet at Hamilton City, Cal., by Prof. E. S. G. Titus, and in 1914 from Rio Piedras, Porto Rico, on sugar cane, by Mr. Thomas H. Jones (Hood, 16).

FOOD PLANTS.

The sugar-beet thrips has confined itself chiefly to plants grown in the greenhouse, but it has been taken out of doors on sugar beets (Beta) and sugar cane (*Saccharum officinarum*). Hinds in 1902 listed the following food plants: *Amaryllis* sp., Aralia, calla (Arum), the night-blooming Jessamine (*Cestrum nocturnum*), Chrysanthemum, Crinum, cucumber (Cucumis), Dracaena, Amazon lily (*Eucharis grandiflora*), India-rubber tree (*Ficus elastica*), *F. grandiflora*, Gardenia, cotton (Gossypium), Hydrangea, *Mina lobata*, moon flower (*Ipomoea bonanot*), screw pine (Pandanus), date palm (Phoenix),

[1] Figures in parentheses refer to Bibliography, p. 11.

yellow calla (*Richardea aethiopica*), tomato (Lycopersicum), and grape (Vitis).

The writer has also found it on Begonia, spinach (Spinacia), sweet potato (*Ipomoea batatas*), string beans (Phaseolus), and Mexican tea (*Chenopodium ambrosioides*).

EXTENT AND NATURE OF INJURY.

The injury caused by the sugar-beet thrips is similar to that of the other species of thrips of the group. The plant is attacked by the adult and nymphs in the same manner. The leaf cells are pierced, and the plant juices withdrawn, causing the cells to shrivel and turn white. When a number of these cells are destroyed they appear as irregular white or light-brown spots. If the attack is severe, the whole leaf surface becomes invested by these spots and finally shrivels and dries. The nymphs also render the plant unsightly through the brown watery excretion from the alimentary tract, which discolors the leaves.

Plate I shows a leaf of Swiss chard attacked by this thrips.

HABITS OF NYMPHS OF FIRST AND SECOND STAGES.

When ready to emerge, the young nymph breaks through the thin eggshell and pushes its way upward until all but the last abdominal segment is free. It remains upright and supported by the last segment until the appendages which are folded beneath the body unfold and become sufficiently hard for use. The forelegs are the first to unfold, followed by the middle and hind pair. The antennæ are now brought forward. The nymph then places its legs on the surface of the leaf and by constant pulling frees the body. A period of from 20 to 25 minutes is required for complete emergence.

The newly-hatched nymphs crawl about for a short time before commencing to feed. They usually collect and feed in colonies on the underside of the leaf, but if food is not abundant, both sides are attacked. Shortly after feeding, the body becomes discolored by the ingested food. The watery excretion from the alimentary tract is collected as a globule, which extends over the entire body except the head, and increases in size until it becomes too large to carry. It is then dropped and spreads over the leaf, giving it an unsightly appearance. The older nymphs are very active and when disturbed move rapidly, with the tip of the abdomen extended upward.

When full grown, the nymph seeks a secluded spot in which to transform. The curled portions of dead leaves form a favorite place of concealment, although the base of the plant and the portion of the leaves along the midribs may be selected.

HABITS OF NYMPHS OF THIRD AND FOURTH STAGES.

The nymphs of the third and fourth stages congregate at some isolated portion of the plant, as along the midribs, at the base, or among the dead or dying leaves (fig. 1), where they remain during transformation. When the attack on the plant has been severe, they will be found more often among the dead leaves.

The third-stage nymph remains practically motionless unless disturbed, when it becomes active and moves rapidly. While at rest it is flattened against the leaf surface.

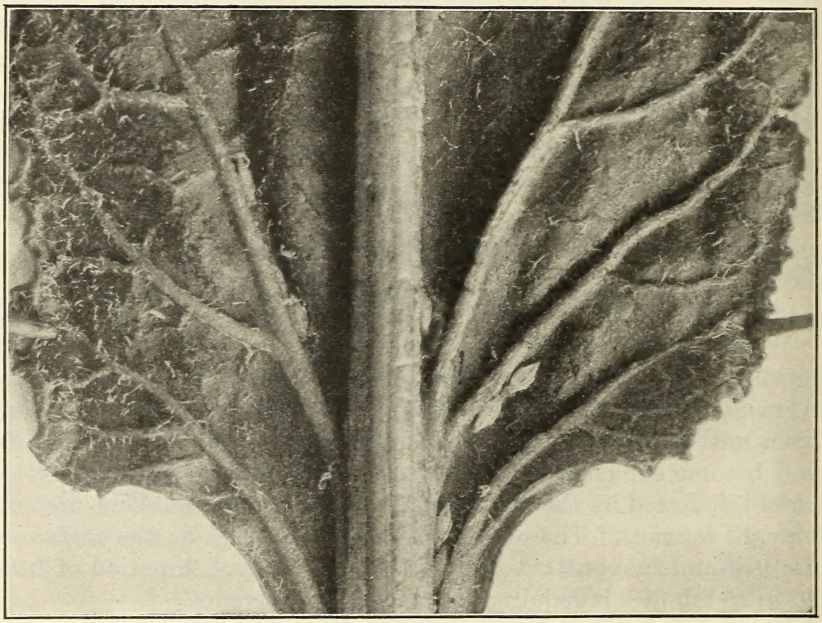


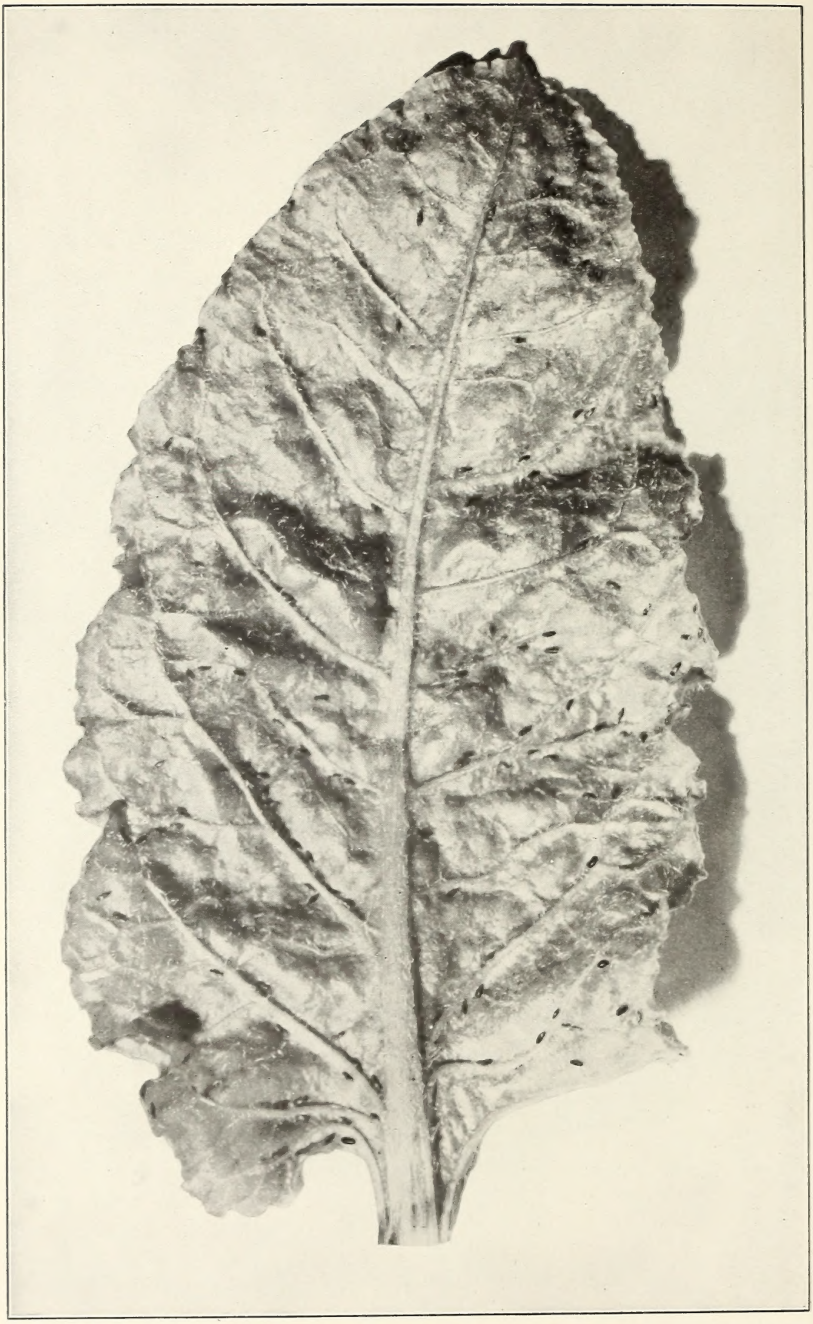
FIG. 1.—The sugar-beet thrips (*Heliothrips femoralis*): Section of sugar-beet leaf showing fourth-stage nymphs along midribs. Enlarged. (Original.)

The nymph of the fourth stage remains motionless and in the same position as in the preceding stage. It is not so active, moving sluggishly and only for a short distance when disturbed.

HABITS OF THE ADULT.

When the adult emerges from the pupa case it is light yellow and very delicate, but as it hardens it gradually assumes its characteristic normal dark brown or black. It remains for a short period in the spot where it transformed before seeking food. As in the mature stages, nourishment is obtained by puncturing the leaf cells and withdrawing the plant juices, the adult apparently requiring less food than the nymph. While resting it remains flattened against the leaf surface along the veins and other parts of the plant. It crawls slowly

WORK OF THE SUGAR-BEET THRIPS (HELIOTHRIPS FEMORALIS) ON SWISS CHARD. (ORIGINAL.)



LEAF OF BEET SHOWING ADULTS OF SUGAR-BEET THRIPS. (ORIGINAL.)

about on the leaf with the abdomen curved downward, but if disturbed moves rapidly away with short, quick leaps. It seldom takes wing, although the writer has twice observed flight for a short distance.

A beet leaf showing the adult at rest is illustrated in Plate II.

The adult males are smaller and more active than the females, which usually greatly outnumber them, although at times the proportion becomes nearly equal. Copulation takes place during the day, as has been observed on a number of occasions.

Oviposition usually takes place at night or in the evening, but has been observed late in the afternoon.

DESCRIPTIVE.

THE EGG.

Egg (fig. 2) translucent white; surface without sculpture; elongate reniform, slightly flattened at cephalic end. Average length 0.249 mm.; width 0.108 mm. Deposited usually on the underside, obliquely to the surface, and beneath the epidermis of the leaf or stem.

When the embryo begins to develop, the egg becomes swollen and turns dull white.

FIG. 2.—Eggs of sugar-beet thrips. Enlarged. (Original.)

THE NYMPH.

First stage (fig. 3).—Fusiform, translucent white; head, eyes, legs, and prothorax large in proportion to the rest of the body; length 0.481 mm.

Head subquadrate; slightly rounded in front. Length 0.083 mm.; width at eyes 0.103 mm. The eyes dark red, ocelli absent. Antennæ, length 0.249 mm.; the segments confused with the exception of 2 and 3, which are separate; segments 1 and 2 cylindrical, bearing spines on outer margins; segment 2 slightly longer; segment 3 pedunculate, annulate, bearing spine on outer anterior margin; segment 4 fusiform, annulate, nearly twice as long as 3, bearing two spines on upper margin; segments 5, 6, 7, and 8 slender and tapering toward apex; spine on outer margin of segment 5. The head bears two pairs of setæ dorsally, and one in front of the eye on the outer margin. Prothorax large, transverse, rounded at the margins, bearing one pair of setæ on lateral margin; length 0.09 mm.; width 0.146 mm. Mesothorax, width 0.398; mesothorax and metathorax each bear a pair of setæ on outer margin, and one pair dorsally. Legs translucent, robust, bearing numerous short spines. Abdomen tapering posteriorly, segments subequal in length, with the exception of 9 and 10, which are longer; 9 about half as long as 10. Each segment, except 9 and 10, bears three pairs of setæ; one pair on the lateral margin, and two on the dorsum; segments 9 and 10 bear 2 pairs. The mesothorax and segments 2 and 8 of the abdomen each bear a pair of spiracles.

Second stage (fig. 4).—Body fusiform, translucent, tinged with faint yellow. Length 1.41 mm.

Head subquadrate, rounded and narrowed in front; about as wide as long; length 0.099 mm.; width 0.133 mm. at eyes. Antennæ 8-jointed, all segments distinct except 7 and 8, which do not appear to be movable; segments 3, 4, 5, 6, and 7 annulate. Length 0.332 mm. The prothorax transverse, narrowed toward the head; width 0.294 mm.; length 0.149 mm. Mesothoracic angles prominent; width of mesothorax

0.315 mm.; one pair of setæ on each lateral margin of the prothorax, and one on the posterior margin; two pairs on the dorsum of the mesothorax and metathorax.

Abdomen tapering gradually posteriorly until the ninth segment, then abruptly. Segments 9 and 10 much narrower than the rest and bearing the rudiments of a pair of obtuse spines on the posterior margins. The first abdominal segment bears one pair of lateral setæ; segment 9, one pair dorsally and one laterally; segment 10 bears one pair; the remaining segments bear two pairs dorsally and one pair laterally.

Third stage (fig. 5).—Head subquadrate, wider than long; length 0.116 mm.; width 0.166 mm. Eyes dark red, small; ocelli absent. Antennal cases, segments confused; only five apparent; length 0.265 mm.

Prothorax transverse, half as long as broad; length 0.133 mm.; width 0.266 mm.; a row of setæ on the lateral and posterior margins. Mesothoracic angles prominent;

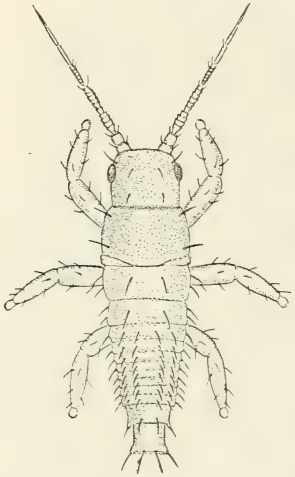


FIG. 3.—Newly-hatched nymph of sugar-beet thrips. Enlarged about 160 diameters. (Original.)

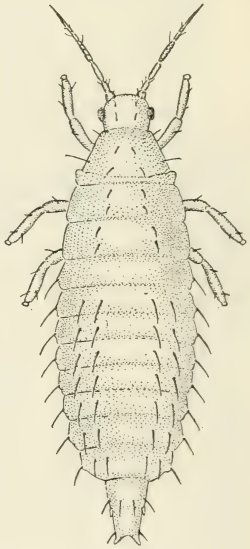


FIG. 4.—Second-stage nymph of sugar-beet thrips. Enlarged about 40 diameters. (Original.)

width of mesothorax 0.299 mm. The wing pads reach to the third abdominal segment. Length of wing pads from the base to the tip 0.299 mm.; the hind pair the longest. Abdomen fusiform, tapering slightly anteriorly; the last two segments are much narrower than the rest, and bear on their posterior margins two large obtuse spines, which extend upward.

Fourth or last stage (fig. 6).—Color translucent white; length 1.469 mm.

Head subquadrate, faintly reticulate; wider than long; length 0.12 mm.; width 0.199 mm. Eyes dark red; three ocelli present, lighter in color than eyes. Antennal cases folded back over the head, the apices extending to the middle of the prothorax, the cases coming in contact beyond the middle of the head. Segments confused; 1 and 2 protruding in front of the head. Segment 2 bears four setæ, two long and two short ones, extending forward. The head bears four setæ, one behind each eye and two small ones between the antennal cases. The newly formed antennæ may be seen through the wall of the case

Prothorax transverse, about three-fourths as wide as long; length 0.158 mm.; width 0.232 mm.; margins rounded; a row of setæ extending around the margins, with the exception of the anterior margin. Mesothoracic angles prominent and acute; width 0.282 mm. Wing pads extend to the middle of the fifth abdominal segment, each forewing pad bearing 12 to 13 short spines; length of wing pad from base to apex 0.564 mm.

Abdomen fusiform, tapering slightly anteriorly; segments 9 and 10 much narrower than the rest, each bearing a pair of large obtuse spines, which extend upward. Each segment except 1, 9, and 10 bears two dorsal pairs of setæ, one placed laterally and

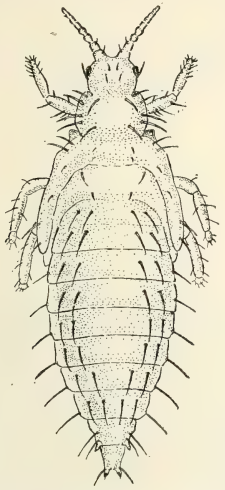


FIG. 5.—Third-stage nymph of sugar-beet thrips. Enlarged about 40 diameters. (Original.)

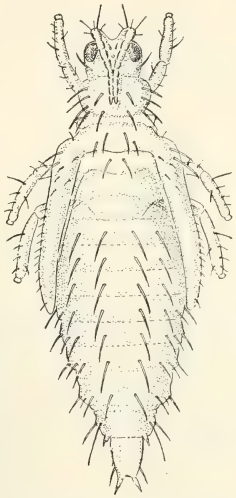


FIG. 6.—Fourth-stage nymph of sugar-beet thrips. Enlarged about 40 diameters. (Original.)

one sublaterally. The first segment is without setæ, and 9 bears two pairs on lateral margin; 10 bears only one pair.

Legs translucent white, bearing numerous short spines, with one long spine on the tibiæ.

THE ADULT.

The adult female (fig. 7) is described by Hinds as follows:

HELIOTHRIPS FEMORALIS REUTER.

Female.—Length 1.3 mm. (1.12 to 1.5 mm.); width of mesothorax about one-fourth the body length. General color dark brown to yellowish brown, lighter at extremities. Entire surface of body weakly but plainly reticulated.

Head two-thirds as long as broad, widest in front; anterior margin depressed at insertion of antennæ; vertex carinated; bases of antennæ separated by a prominence as high and nearly as wide as the first antennal segment; two transverse wrinkles near back of head more prominent than the others; behind the anterior one of these two the longitudinal parts of the reticulations become very faint; spines upon head scattering and small. Eyes quite large, protruding anteriorly, coarsely granulated; eyes and margins of ocelli bright, dark red by reflected light; ocelli placed on sides

and front of a distinct elevation on top of head between eyes. Head light brown with light yellowish longitudinal stripe on each side between eye and ocelli. Maxillary palpi three-segmented, short, small; labial palpi minute. Antennæ eight-segmented, slender, nearly three times as long as head; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
5	8.8	16.6	12.2	11	8.6	4.3	10.5

Segment one cylindrical, three-fourths as broad as two, which is barrel-shaped and annulated; remaining segments narrower than these two and more elongated; three and four fusiform; seven and eight nearly cylindrical; eight very slender; one, two, and three nearly concolorous, light yellow with tinge of gray or brown on one and two; four and five light yellow in basal half, shading to light brown on apical half; six,

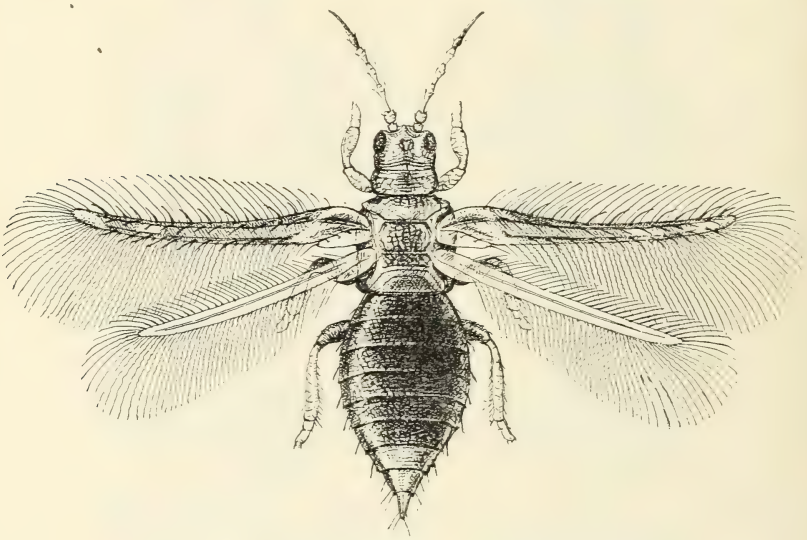


FIG. 7.—Adult female of sugar-beet thrips. Enlarged. (Original.)

seven, and eight uniformly chocolate brown; segments two to five annulated; spines slender, light colored.

Prothorax transverse, about one-fifth wider than the head, twice as wide as long and shorter than the head; sides rounded; without conspicuously large spines. Mesothorax about one and two-thirds times as wide as the head; anterior angles prominent; mesonotum with deep incision on posterior margin; metanotum with four spines standing in a square near its center. Wings present, long, about one-sixteenth as broad as long; fore wings broadened at base, with two longitudinal veins, the second branching from the first not far from the base of the wing. Spines upon veins of fore wing stout, dark colored, and set at uniform distances; costa bears seventeen to twenty, fore vein fourteen to seventeen, hind vein ten to thirteen, scale three to five besides pair at its tip; spines on basal fourth of wing are light colored, smaller, and much less conspicuous; anterior fringe on both wings fairly long and stout; posterior fringe long, slender, and dark colored. Wings grayish brown to dark gray, lighter between the longitudinal veins; three nearly white cross bands; one across base before branching of veins, another at three-fourths the length of wing and the third across the tip. Legs: All tibiæ, tarsi, and fore femora yellow; middle and hind femora dark brown, yellow only

at ends; spines upon legs small and inconspicuous except ten to twelve on inner side of hind tibiæ.

Abdomen broadly ovoid, conical at tip, twice as wide as head; ovipositor long and slender; tenth segment split open above; segments two to eight with dark cross line near anterior edge. Two or three spines on sides of each segment from two to eight, not conspicuous; anal spines weak. Color of abdomen yellowish brown to dark brown; last two segments much more yellow, but shading to brown at posterior edges.

This species has the power of springing.

A description of the male, which hitherto has not been recognized, is appended.

Male.—The male resembles the female in appearance, but is much smaller and more active. The abdomen tapers gradually posteriorly; the apex (fig. 8) is truncate; the

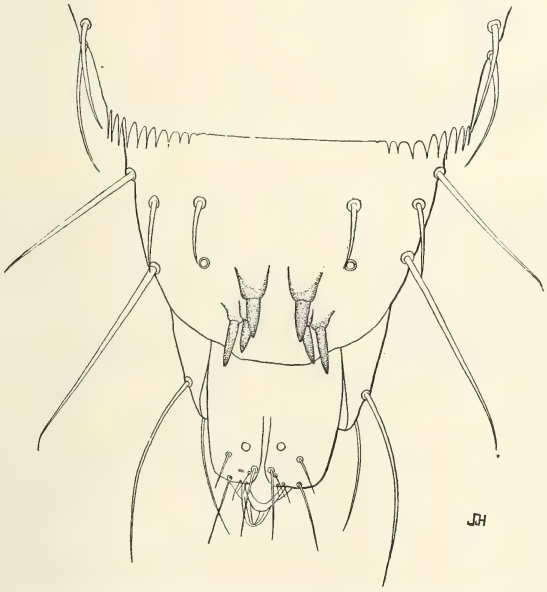


FIG. 8.—End of abdomen of male of the sugar-beet thrips. Greatly enlarged. Drawn by J. D. Hood. (Original.)

last segment is short and broad. Segment 9 bears dorsally three pairs of short, black, obtuse spines, light brown at the base; two pairs near the middle of the segment, and one pair near the posterior margin, and more widely separated.

Measurements: Length of head 0.099 mm.; width of head 0.174 mm.; width of prothorax 0.199 mm; length of prothorax 0.0996 mm.; width of metathorax 0.282 mm.; width of abdomen at third segment 0.299 mm.; length of abdomen 0.73 mm.; length of antennæ 0.299 mm. Total length 1.185 mm.

LIFE CYCLE.

The life history was determined under natural greenhouse conditions. Females were isolated on small beet seedlings, and as soon as they deposited eggs the adults were removed. The temperature and moisture were fairly constant, the maximum temperature being

reached in the middle of the day. The average mean temperature was about 73° F. during the time of development.

The egg requires from 12 to 14 days to develop; the nymph molts four times, the first instar lasting about four days. The second stage transforms to the third in about eight days. The third stage is short, the skin being molted in about a day. The fourth or last stage requires about five days before it emerges as an adult.

The full length of the adult's life was not determined, but adults emerging from isolated pupæ on February 11, 1916, were still alive 40 days later.

The normal mode of reproduction is bisexual, but owing to the fact that at certain intervals the proportion of males to females is very small, it is likely that parthenogenesis occurs as in other species of this group. While this species was under observation males were present most of the time, but in very small numbers, although on one occasion they appeared very abundant, nearly equaling the females.

CONTROL.

In the greenhouse the sugar-beet thrips may be held in check by the application of a strong spray of water to the foliage. This washes the younger stages from the leaf; and as these are unable to reach the food plant again, they die.

As a result of experiments, spraying is the best method of control, both in the greenhouse and out of doors. The following solutions were used:

Experiment No. 1.

Nicotine sulphate	ounces..	4
Fish-oil soap	pounds..	4
Water	gallons..	50

Result: About 60 per cent of adults and 40 per cent of nymphs killed.

Experiment No. 2.

Nicotine sulphate	ounces..	5
Fish-oil soap	pounds..	4
Water	gallons..	50

Result: Ninety per cent of adults and 60 per cent of nymphs killed.

Experiment No. 3.

Nicotine sulphate	ounces..	6
Fish-oil soap	pounds..	4
Water	gallons..	50

Result: All adults and about 95 per cent of nymphs killed.

The fact that the adults were more susceptible to the spray than the nymphs may be due to the globule of excretion which serves to protect the body of the nymph.

The spray should be applied to both sides of the leaves; if possible, on a dull or cloudy day. The adults are not so active at this time and are, therefore, less likely to move out of reach of the spray.

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